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Smolt age and sea age distributions of Atlantic salmon (*Salmo salar* L.) in the sea north of the Faroe Islands during 1991 to 1995

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Abstract

Smolt age and sea age distributions of Atlantic salmon were estimated in the sea north of the Faroe Islands during four consecutive fishing seasons 1991/1992 to 1994/1995. Age compositions where estimated from scale analyses and the fish was classified as being of wild or fish farm origin from scale characteristics. Age composition in samples from the four fishing seasons showed similar trends. Both smolt age and sea age distributions were significantly lower in the autumn part of the fishing season (November-December) than in the winter part of the season (January-March). Smolt age varied between 1-4 years and mean smolt age was 2.5 years in the autumn samples and 2.7 years in the winter samples. Sea age varied mainly between 1-3 years and mean sea age was 1.9 years in the autumn samples and 2.2 years in the winter samples. The significantly lower smolt age and sea age distributions during the autumn suggests that a large proportion of the salmon stocks in Faroes area during this period originate from southern European countries, where a large proportion of the salmon migrate to sea after 1-3 years and many of the stocks inhabiting the Faroese area are grilse stocks. In the winter part of the fishing season the results indicate a higher proportion of salmon from northern European countries with higher smolt and sea ages. Recaptures in the Faroese fishery of salmon tagged as smolt by country of origin support these findings.

Keywords: Escaped farmed salmon, high seas, *Salmo salar*, sea age, smolt age, wild salmon

Introduction

Atlantic salmon (*Salmo salar* L.) are widely distributed in the Northeast Atlantic and have been fished by Faroese long-liners since late 70'ties in the Faroese area and Norwegian Sea (Jákupsstovu, 1988). The fishery exploits mainly two-sea-winter (2SW) salmon, but some 1SW and 3+SW salmon are also caught. In reports from the fishermen and from landing statistics the fish caught during autumn (November-December) seemed to be of smaller size than the fish landed during the winter period (January-April). The apparent difference could not be accounted for by the increase in length from growth during the season. This indicated a possible difference in the population structure (e.g. sea age characteristics) which could have aroused from a change in the origin of the salmon in the Faroes area during the fishing season. Such changes could be plausible when considering the main current system in the Northeast Atlantic in relation to temporal and spatial differences at time of smoltification and seaward migration from various countries around the Norwegian Sea. Furthermore, the smolt and sea age distributions are generally lower from salmon in the southern European countries (i.e. UK (Scotland, England & Wales), Ireland, France and Spain), compared to the northern European countries (mainly Norway and Russia). Recapture at Faroes of salmon tagged as smolt in several countries has revealed that fish from many countries bordering the Northeast Atlantic are present in the Faroese area at some part of their life in the sea (Anon. 1997). Be it during their entire oceanic life or as 1SW and 2SW salmon on their way to and from their home river. Recent results from the sea tagging experiment of adult salmon north of the Faroes do support the high number of countries from which salmon migrates from to the Faroese area (Hansen & Jacobsen, 1997).

The aim was to estimate the smolt and sea age composition of wild salmon in the area north of the Faroes. Such estimates have the potential to identify the population structure and to some degree the origin of the salmon in the Faroes area during parts of their oceanic phase. Thus we test the hypothesis that there is no difference in the smolt and sea age distributions of wild salmon between autumn and winter.

Materials and methods

As a part of a continued biological sampling program of Atlantic salmon in the exploratory long-line fishery within the Faroes EEZ, fish were examined in order to estimate the smolt age and sea age compositions of wild salmon. Areas fished during the 1991/1992 to 1994/1995 fishing seasons at Faroes are shown in Figure 1. The autumn fishery (Nov-Dec) is located closer to the isles and more westerly than the winter fishery (Jan-Apr) which is located further to the northeast. The movement of the fishery is in a northeastern direction as the fishing season progresses. This is a general fishing pattern for salmon in the Norwegian Sea from earlier observations (Anon. 1997).

The scale samples were collected from the dorso-lateral area of the fish as recommended by Shearer (Shearer, 1992).

Escaped farmed fish and fish which could not be positively identified as being of wild origin on the basis of scale analysis (Lund & Hansen, 1991) were excluded from the

analysis. Similarly fish with scales that showed incomplete annual zones or which could not be accurately assigned to a specific age group were also excluded from the analysis. Of 2,350 fish analysed 1,525 (64.9%) fish were positively identified as being wild salmon. Of these 1,525 wild fish it was possible to assess smolt age from 1,335 (87.5%) fish and sea age from 1,520 (99.3%) fish. The sample size for the different fishing seasons varied from 190 to 536 fish (Table 1).

The term autumn refers to the fishing period from November to December in any given fishing season and the term winter refers to the period January to April. In some fishing seasons, particularly in recent years the winter period is shorter and lasts from February to March. Chi-square tests were used to test for differences in smolt and sea age distributions between periods, and t-tests (assuming unequal variances) were used to test for differences in mean smolt and mean sea age between periods and among seasons.

Results

Age composition in samples from the four fishing seasons showed similar trends. Both smolt age and sea age were lower in the autumn part of the fishing season than in the winter part of the season.

Smolt age varied between 1-4 years in most samples and included some smolts that were five years old. These were added to smolt age group 4+. Mean smolt age during the four fishing seasons varied between 2.3-2.6 years in the autumn samples and between 2.7-2.8 years in the spring samples (Table 2). The mean smolt was significantly lower during autumn (mean smolt age 2.5 years) than in the winter period (mean smolt age 2.7 years) (t-Test, df=4, p= 0.031). The smolt age distributions were significantly different between the autumn and spring samples in all fishing seasons (1991/92: df=2, p=0.02; 1992/93: df=2, p<0.001; 1993/94: df=2, p=0.001; 1994/95: df=2; p<0.001). The smolt age distributions for the pooled data are shown in Figure 2.

Sea age varied mainly between 1-3 years. Some samples included a few specimens of sea age 4-6, and they were added to sea age group 3+. Mean sea age during the four fishing seasons varied between 1.8-2.0 years in the autumn samples and between 2.1-2.4 years in the spring samples (Table 3). The mean sea was significantly lower during autumn (mean sea age 1.9 years) than in the winter period (mean sea age 2.2 years) (t-Test, df=6, p= 0.009). The sea age distributions were significantly different between the autumn and spring samples in all fishing seasons (df=2, p<0.001 for all four seasons). The sea age distributions for the pooled data are shown in Figure 3.

No differences were observed in mean smolt age or sea age among seasons.

Discussion

The lower smolt and sea age compositions observed of wild salmon in the area north of the Faroes leads to a rejection of the null hypothesis. Thus we suggests that the different population structure between autumn and winter could be due to a major proportion of the salmon stocks found in the Faroes area during the autumn period originate from

southern European countries while more salmon from northern European countries inhabit the Faroese area during the winter period.

Large proportions of smolts from the southern European countries migrate to sea after 1-3 years and many of the stocks inhabiting the Faroese area during autumn are grilse stocks (Anon. 1997). Recoveries of microtagged fish from Ireland and Scotland supports the southern origin during autumn as a higher proportion of tags are recovered from those countries during this period compared to later in the season (Anon. 1997). In the winter part of the fishing season the results indicate that a higher proportion of salmon from northern European countries with higher smolt and sea ages inhabit the Faroese area. External tag recoveries from Norway and Russia during the winter period together with the nearly absence of microtag recoveries from the southern countries during winter also support this view (Anon. 1997).

The indicated change in the proportion of fish from different countries during autumn and winter might be explained by temporal and spatial differences when the smolt migrate to sea in relation to the main current system in the Northeast Atlantic –the North Atlantic Drift. Both the timing of seaward migration and the initial location of the smolts are likely factors to influence the postsmolt migration route and to where the salmon eventually ends in the ocean during late autumn. The majority of the north European smolt might be located further to the north in Nov-Dec than smolt from the southern countries and thus appears to be less represented in the autumn catches compared to later in the fishing season. Holst *et al*. (Holst *et al.*, 1996) found that postsmolts of river age 2 and especially 3+ (i.e. from northern countries) seemed to be missing from pelagic trawl catches during summer in the Norwegian Sea and they proposed a similar explanation that the northern postsmolt were outside their sampling area.

New findings of postsmolt in the Norwegian Sea from west of the Hebrides up to Jan Mayen during summer (Holst *et al.*, 1993; Holm *et al.*, 1996; Holst *et al.*, 1996) throw some light on the distribution of postsmolts in the Northeast Atlantic, however, little or no information on the difference in spatial separation of smolt from different countries is available. Further studies on postsmolt migrations are necessary to investigate such speculations.

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Table 1. Number of scales samples analysed from wild salmon north of the Faroes by season (1991/92-1994/95).

Season	Autumn (Nov-Dec)	Winter (Jan-Apr)	Total sample whole season
1991/92	188	320	508
1992/93	65	125	190
1993/94	256	280	536
1994/95	120	171	291
1991-1995	629	896	1525

Table 2. Smolt age distribution in numbers within age classes (% in brackets) of wild salmon in samples from the Faroes salmon fisheries (1991/92 – 1994/95). Age group 4+ includes 5-year-old smolts in samples. Mean smolt age is given for each period.

			Autumn (Nov-Dec)						Winter (Jan-Apr)						
			Smolt age						Smolt age						Whole
Season	Autumn	Winter	1	2	3	4+	Mean	Total	1	2	3	4+	Mean	Total	Season
1991/1992	Dec	Feb–Apr	14 (8)	70 (39)	68 (38)	27* (15)	2.6	179	8 (2)	105 (41)	144 (51)	39* (6)	2.7	296	475
1992/1993	Nov–Dec	Mar	5 (12)	21 (53)	12 (30)	2 (5)	2.3	40	0 (0)	34 (33)	57 (55)	12* (12)	2.8	103	143
1993/1994	Nov–Dec	Jan–Mar	32 (16)	74 (36)	68 (34)	29* (14)	2.5	203	11 (4)	86 (37)	99 (44)	40* (15)	2.7	236	439
1994/1995	Nov	Feb–Mar	7 (6)	57 (50)	31 (27)	20 (17)	2.6	115	1 (1)	66 (41)	67 (41)	29* (18)	2.8	163	278
1991-1995			58 (11)	222 (41)	179 (33)	78* (15)	2.5	537	20 (3)	291 (36)	367 (46)	120* (15)	2.7	798	1335

* Samples including 1-4 individuals of smolt age 5.

Table 3. Sea age distribution in numbers within age classes (% in brackets) of wild salmon in samples from the Faroes salmon fisheries (1991/92 – 1994/95). Age group 3+ includes sea age 3 and higher in samples. Mean sea age is given for each period.

			Autumn (Nov-Dec)					Winter (Jan-Apr)					
			Sea age					Sea age					Whole
Season	Autumn	Winter	1	2	3+	Mean	Total	1	2	3+	Mean	Total	Season
1991/1992	Dec	Feb–Apr	15 (10)	159(86)	14* (4)	2.0	188	2 (1)	252 (80)	64* (19)	2.2	318	506
1992/1993	Nov–Dec	Mar	20 (31)	41 (63)	4* (6)	1.8	65	1 (1)	75 (60)	49* (39)	2.4	125	190
1993/1994	Nov–Dec	Jan–Mar	20 (12)	212 (73)	22 (15)	2.0	254	65 (23)	140 (48)	75* (29)	2.1	280	534
1994/1995	Nov	Feb–Mar	23 (19)	93 (78)	3 (3)	1.8	119	5 (3)	137 (80)	29* (17)	2.2	171	290
1991-1995			78 (12)	505 (81)	43* (7)	1.9	626	73 (8)	604 (68)	217* (24)	2.2	894	1520

* Samples including 2-12 individuals of sea age 4 and 5, and one aged 6 years.

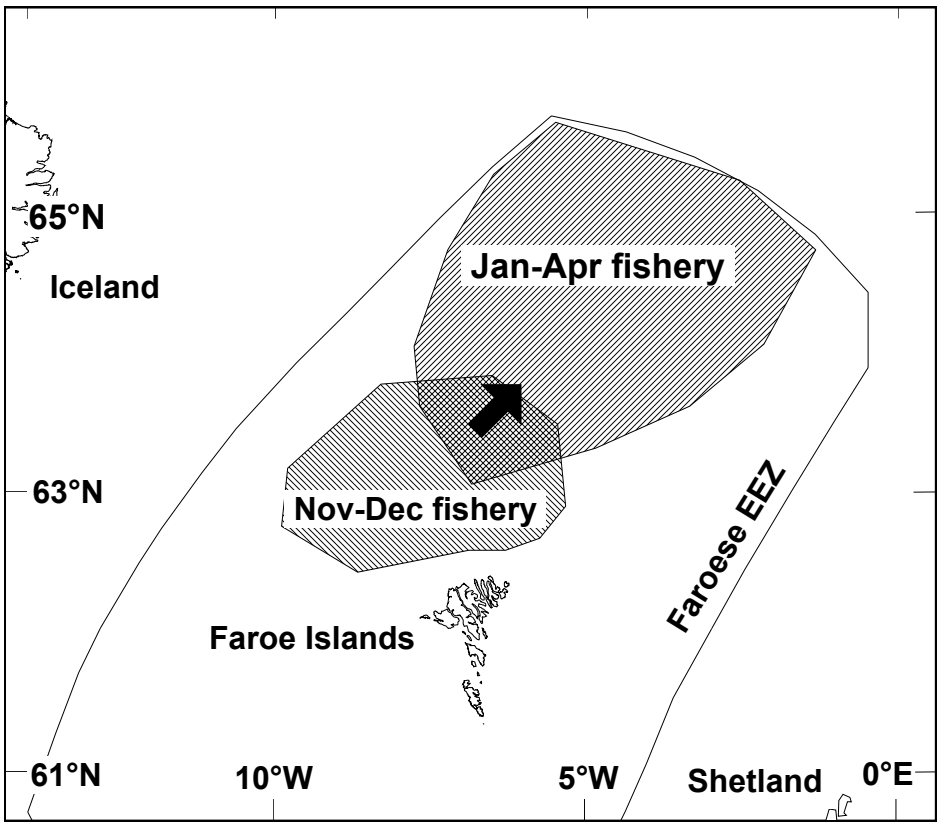

Figure 1. Areas fished during the tagging experiment at Faroes (1992/1993 – 1994/1995). The autumn fishery (Nov-Dec) is located closer to the isles and more westerly than the winter fishery (Jan-Apr) located further to the northeast. The arrow indicates the direction of movement of the fishery as the fishing season progresses.

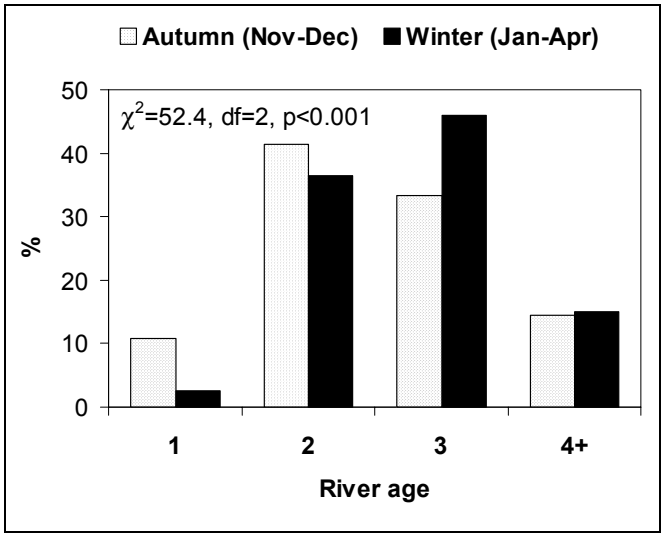

Figure 2. River (smolt) age distribution of wild Atlantic salmon by half season north of the Faroes during 1991-1995. The autumn is defined as Nov-Dec (n= 537) and winter as Feb-Mar (n= 798).

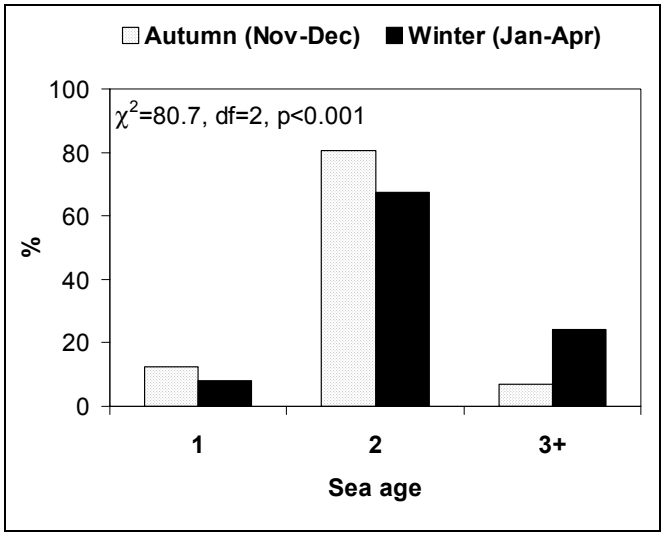

Figure 3. Sea age distribution of wild Atlantic salmon by half season north of the Faroes during 1991-1995. The autumn is defined as Nov-Dec (n= 626) and winter as Feb-Mar (n= 894).